

the roof of the building, which allow of the traverse of the beam, and serve for raising it by means of levers, for the removal of the work.

Near each end of the beam is attached, with the power of adjustment for position, a small adding frame carrying bearings for the reception of the central pivot of the awing table or runner, which consists of a strong frame of wood covered with boards, and measuring 8 feet long and 6 feet wide, placed face downwards upon the bench: a central pivot stands up from the back of the runner, and enters the bearing fixed on the horizontal beam, which thus communicates a circular swinging motion to the centre of the runner, exactly the same as that of the driving crank; and the runner being free to revolve upon its pivot, acquires a continual rotation around its own axis. By the combination of the two movements, the relative position of the fixed bench and runner are continually changing; this tends to the mutual correction of the two surfaces of the glass, and greatly assists the equal distribution of the sand and water used in grinding. The horizontal beam makes about fifty circulating strokes in a minute, and the runners revolve upon their own axes about once to every five or six strokes. The position of the runners upon the driving beam is shifted once or twice during the grinding, to distribute the action as uniformly as possible over the entire surfaces of the glass plates.

The largest plates of glass are nearly equal in size to the fixed bench, and these are imbedded singly upon the bench with the most irregular side upwards; but more generally plates of medium and small size are ground together: they are selected of uniform thickness, and arranged close together upon the bench, with the largest plates in the middle and the smallest at the ends. The runner is covered by one or two plates at most, as small pieces would be liable to be thrown off by the centrifugal force.

All the irregularities of the surfaces are first ground out with sharp river sand, that has been washed and sifted into two sizes; the sand and water are thrown on by hand occasionally, and when the plates have been ground quite flat, the finer sand is employed, and followed by emery of two finer sizes, applied as usual in succession, in order to remove the scratches made by the coarser powders. The plates of glass are thoroughly washed between every change of grinding powder, and when the one side of the glass has been ground with the finer sizes in succession, the plates are inverted, and the same routine is followed on the second side.

The grinding machines do not, however, admit of being employed with very fine emery, as the close approximation of large surfaces travelling over each other at a considerable velocity, causes so much friction that it would be liable to tear the surface of the glass, and, consequently, as the plates become sufficiently smooth to require the application of fine emeries, the velocity and pressure should be proportionally reduced, and a greater degree of care and management is required; it is therefore found to be preferable to effect the smoothing of plate glass by hand.

The plates are smoothed upon stone benches of suitable size, about 2 feet high, made very flat upon their surfaces, and covered with wet emery. One large plate nearly equal to the size of the bench, and two or three plates of about half the size, are usually given out as a set of work. The large plate is laid upon the wet canvas which serves to hold it firmly, emery and water are spread over the surface, and one of the small plates is used as a grinder or runner. If the plates be large, a few flat lead weights of about 14 lbs. each are laid near the middle of the runner, to distribute the pressure uniformly, and the runner is traversed over the lower plate with a swinging stroke backwards and forwards, so as to describe nearly a semicircle around the centre of the runner, which is at the same time shifted a few inches during the stroke. Every stroke follows a slightly different path from the preceding one, and the runner is also gradually twisted round as the smoothing pro-

ceeds. The combination of these movements serves to expose every part of the surfaces of the bed plate and runner to an equal amount of grinding, and also to distribute the emery very uniformly.

Small plates are smoothed by young girls, and large plates, which require greater dexterity and a proportionate increase in the amount of traverse, are smoothed by two women; who stand on opposite sides of the bench, and placing their outstretched hands flat upon the runner, swing it with a stroke of five or six feet. The employment appears most masculine, but it is found that the smoothing is upon the whole executed better by women than men, as only a moderate force is required, and from the greater delicacy of touch possessed by females, they more readily appreciate when any particles of grit have become accidentally mixed with the emery.

About six sizes of carefully washed emery are used in the smoothing, and between every size, the plates, canvas, bench, and hands are thoroughly washed; perfect cleanliness in the clothing is also quite essential, as a particle of coarse grit would make a scratch that would require the smoothing of the plates to be recommenced. The fine emery last employed gives a very smooth and partly polished surface, which is completed with the machine next described.

The polishing machine has a bed 15 feet long and 8 feet wide, that is mounted upon rollers, and slowly traversed sideways, a space of 4 feet to and fro, by means of a rack and pinion beneath. A few inches above the bed are reciprocated longitudinally two beams or carriages, each about 18 feet long and 9 inches wide, and consisting of two cast-iron side-plates connected together at intervals, and supported at each end upon two small wheels, that run upon a short railway at the end of the traversing table. The carriages are placed 4 feet asunder, and reciprocated about 2 feet by means of two cranks fixed opposite to each other on the same axis, so that the beams work in opposite directions, the one advancing as the other recedes.

The plates of glass are embedded close together, with their surfaces quite level, upon moveable platforms that are afterwards fixed upon the traversing bed, and the polishing is effected with a series of rubbers, placed 1 foot asunder, and measuring 8 by 6 inches, covered with thick felt, and attached to the reciprocating carriages, which drag the rubbers backwards and forwards over the surface of the glass, while the latter is traversed beneath the rubbers, a space equal to the distance between the two lines of rubbers, to expose all parts of the glass equally to their action.

Every rubber is separately attached to one of the two carriages, to allow it to ply uniformly to the surface of the glass: this is effected as follows:—Between the two side-plates of the beam are fixed, near the top and bottom edges, two cross pieces having square holes, through which slides vertically a square bar, the lower end of which projects about 2 inches below the beam, and is rounded semi-cylindrically. The rubber is made quite detached, with a central cavity at the back to fit the end of the upright bar, which thus forms a joint that allows the rubber to adjust itself to any trifling irregularities of the surface over which it is traversed, and the rubbers admit of being readily removed while the plates of glass are being exchanged. The pressure is given separately upon every rubber by two lead weights of about 15 lbs. each fixed one on each side of the upright bar.

The powder generally employed for polishing plate glass by machinery is the Venetian pink of the colour-man, a cheap powder which contains only a small proportion of the oxide of iron, mixed with earthy matter that renders the powder less active, and allows of the free use of water, which serves to reduce the friction and prevent the glass becoming heated by the action of the rubbers. Tripoli, crocus, or putty powder, used with water, are too active to produce a high polish on glass, and therefore they are generally employed dry for the last finish of glass polished by hand. But the great amount of rubbing surface, the velocity

and power employed for polishing plate glass by machinery, render the use of dry powders inadmissible, as the surface would be torn by the friction, and the heat evolved would be liable to break the glass.

Sometimes old plate glass, that has become scratched, is repolished: when the plates are large, and sufficiently numerous, they are repolished by machinery, just the same as new glass, but more generally old plates are repolished by hand, as the process can be then restricted principally to the scratched portions of the surface.

The polishing is commenced with tripoli on cloth rubbers of the usual form, and finished with putty powder or crocus. The pressure is generally given as in hand calendering, by attaching the rubber to the lower end of an upright pole, suspended from a long horizontal spring fixed overhead, like that of a pole lathe. The elasticity of the spring supplies the pressure, and the workman has only to push the rubber backwards and forwards; but the process is both laborious and tedious with large plates, and, from the irregular action of the hand, the surfaces of glass thus polished present a wavy appearance much inferior to those polished by machinery.

Sheet glass or flattened glass is manufactured by blowing the glass first into the form of a spherical bulb, which is afterwards elongated, by alternate heating, blowing and swinging, into a cylinder about 3 feet long and 8 inches diameter, with rounded ends, which, as the last process of blowing, are opened out, and the ends are cut smooth with a diamond traversed in an upright frame around the cylinder, which is then cut through on the one side longitudinally, with a diamond inserted near the extremity of a light rod, and drawn through the inside of the cylinder under the guidance of a straight edge. The cylinder is then placed with the cut upwards in a reverberatory furnace, and the heat causes the cylinder gradually to open as a sheet, which is gently flattened down on the bed of the furnace, with tools like blunt garden rakes, made of iron or wood.

To improve the flatness, several sheets are afterwards laid upon each other in a second reverberatory furnace with a level bed: the heat of the furnace, and the weight of the superincumbent mass, causes the lower sheets of glass to become sufficiently flat for ordinary use, notwithstanding that there are many little irregularities in its surface, arising from the imperfect action of the flattening process. For the best purposes these irregularities are removed by grinding and polishing.*

Books.

Report of the Proceedings of the British Archaeological Association, at the Fifth General Meeting, holden in Worcester, in August, 1848. Edited by ALFRED J. DUNKIN, Member of the Committee of the Worcester Congress. J. Russell Smith, Old Compton-street, Soho. Only 120 printed. 1851.

We have here a pleasant reminiscence, by Mr. Dunkin, of all the various papers, notes, and memoranda collected during and since the Worcester congress, dedicated to Mr. C. Roach Smith, and illustrated with a variety of engravings. The whole forms a goodly volume of 456 pages, besides an index, and appears to be a diligent compilation of the proceedings.

First Book on Plane Trigonometry: comprising Geometrical Trigonometry, and its Application to Surveying. By G. W. HAMMING, M.A., &c. Taylor, Walton, and Maberly, Paternoster-row.

THIS little volume is intended for the use of schools. It contains numerous examples, and, considering the new aspect which the science of surveying has assumed, cannot but be useful as well as interesting to students and others who have had but little time to devote to such studies. It is to be followed by a short treatise on analytical trigonometry and calculation of logarithmical, and trigonometrical tables.

* From the third vol. of Hutton's *"Turning and Mechanical Manipulation,"* noticed in a late number.